Spin wave "wells" in non-ellipsoidal magnetic elements

Andrei Slavin , Oakland University, Michigan, DMR-0072017

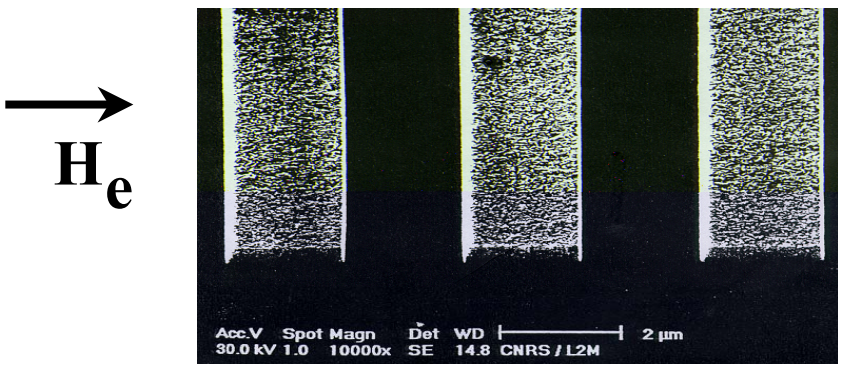
SPIN WAVE (SW) MODES IN PATTERNED MEDIA

1. Progress in magnetic recording led to the development of a NEW (patterned) film media for magnetic recording, where each bit is written in a single pattern element.

2. To achieve fast (sub-nanosecond) "precessional" re-magnetization of a pattern element it is necessary to have the duration of a "writing" pulse equal to half a period of a spin wave eigen-frequency in the pattern element.

3. Thus, it is necessary to study eigen-frequencies of SW modes in small non-ellipsoidal magnetic elements.

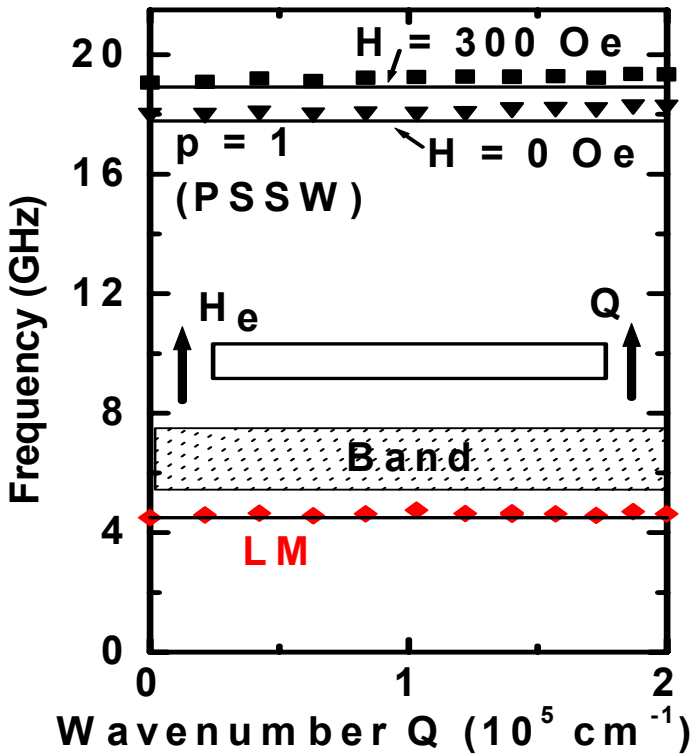
Example of a patterned recording medium: permalloy stripes magnetized along their width



EXPERIMENT

1. Spin wave eigen-frequencies in permalloy stripes magnetized along their width were measured by Brillouin light scattering in the group of Prof. Hillebrands, Kaiserslautern, Germany.

2. A NEW strongly spatially localized spin wave mode (LM) of unknown nature was discovered.



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WE FOUND:

(i) That inhomogeneous bias magnetic field inside a non-ellipsoidal magnetic element forms "potential wells" for spin waves in which spin wave modes are localized.

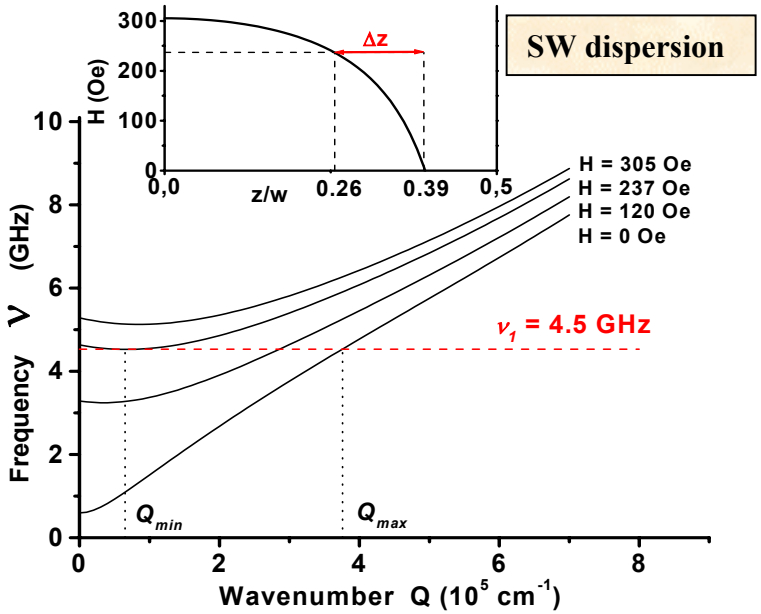
(ii) Although the localized mode (LM) is the lowest in the spectrum, it is of a purely EXCHANGE nature.

(iii) The quantization condition for the LM has the integral form

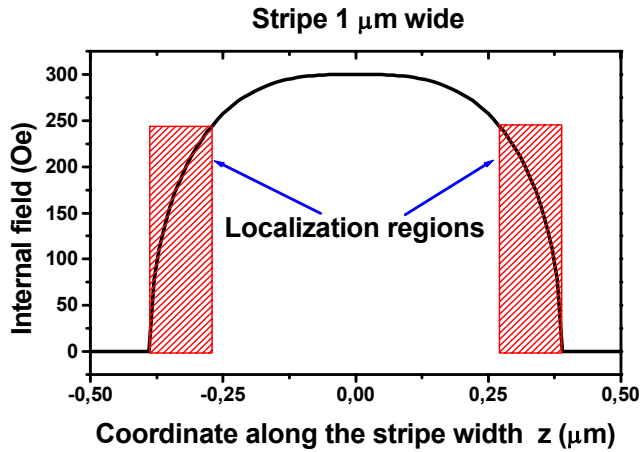
$$\int_{z_{\min}(\nu)}^{z_{\max}(\nu)} Q_z[H(z),\nu]\,dz = \pi$$

(iv) The developed theory allows us to calculate the localization length (0.13 μm) and the frequency (4. 52 GHz) of the LM, that are in good agreement with the experimental data.

SW dispersion



Internal field and regions of mode localization



Results were published in :

Phys. Rev. Lett. 88, art. # 047204 (2002).

The following students have gained a great deal of expertise by performing calculations of SW mode localization:

Russell Kouba (undergraduate)
Radoslav Bozinoski (undergraduate)
Paul Wierzbicki (graduate)